Chapter 2 Laser-Based Manufacturing Processes for Aerospace Applications

Panos Stavropoulos Hellenic Air Force Academy, Greece

Angelos Koutsomichalis Hellenic Air Force Academy, Greece

Nikos Vaxevanidis School of Pedagogical and Technological Education, Greece

ABSTRACT

In this chapter the latest developments in Laser manufacturing technologies and processes, used in the aerospace industry, are discussed. Current developments in the aerospace industry are characterised by the reduction of manufacturing and exploitation costs. Thus, the need for implementation of advanced manufacturing technologies and processes in the aeronautic industry, offering cost effective products with improved life cycle, is becoming more and more imperative. Lasers can be used in many industrial machining processes for a variety of materials including metals, ceramics, glass, plastics, and composites. Laser beams, used as machining tools, are not accompanied by problems such as tool wear, tool breakage, chatter, machine deflection and mechanically induced material damage, phenomena that are usually associated with traditional machining processes. The effectiveness of Lasers depends on the thermal nature of the machining process. Nevertheless, difficulties arise due to the difference in the thermal properties of the various components.

DOI: 10.4018/978-1-5225-0329-3.ch002

INTRODUCTION

The advantages of laser processing in many production applications in terms of cost, time, quality and flexibility, have led a substantial number of aerospace related companies the latest years to adopt laser processing systems, despite their high investment costs. Lasers present high flexibility as manufacturing "tools", since a number of different in nature processes can be realized with the same laser source, including machining, welding, surface and heat treatments, in a variety of materials such as metals, plastics, composites, ceramics wood and glass. Moreover the development of high power lasers (> 2-3 kW) in combination with high speed moving (flying) optics or work piece positioning devices met in today's laser systems, have increased dramatically the production rates of laser processing.

However it is common practice in many industrial environments such technologies not to be fully exploited due to lack of adequate technical know-how. Usually laser equipment is utilized mostly for laser cutting and rarely laser welding of a very specific family of materials, including in most cases mild steels, stainless steels and sometimes Aluminum Alloys. Laser drilling has been used for producing cooling air holes, whereas laser cutting has been used fabricate a large variety of sheet-metal parts such as compressor vane segments. Laser welding, although very popular in other industrial sectors, such as the automotive, is considered as a niche application in the aerospace related industries finding however few applications in aero engine manufacturing such as the production of compressor stator cascades and join cover plates to the cast cores of high-pressure and low-pressure blades.

The laser was invented in 1960 and has offered to industry a new form of energy. The energy generated from lasers can be employed to heat, melt and vaporize most materials; therefore a laser beam can be the energy source in laser material processing; a number of excellent books presents various aspects on the topic, see (Chryssolouris, 1991, Kannatey-Asibu Jr, 2009 & Steen et al., 2010).

There are various types of lasers with different characteristics depending, to a large extent, on the active medium used for the laser action. The principal laser categories include solid state lasers, gas lasers, liquid dye lasers, semiconductor (diode) lasers and free electron lasers. Ruby and Nd:YAG are examples of solid state lasers. Both are extensively employed in manufacturing applications (Akinlabi et al., 2012).

Laser material processing represents a great number of methods, which are increasingly applied in different industrial sectors as promising alternatives to conventional manufacturing processes. Nowadays, the use of lasers in industrial engineering is an emerging field with a wide variety of applications, for example, in electronics, aerospace, molds and dies and biomedical applications. 20 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: <u>www.igi-</u> <u>global.com/chapter/laser-based-manufacturing-processes-</u> for-aerospace-applications/149836

Related Content

Functional Polymeric Coatings: Synthesis, Properties, and Applications

Peter Zarras, Paul A. Goodmanand John D. Stenger-Smith (2017). *Materials Science and Engineering: Concepts, Methodologies, Tools, and Applications (pp. 648-674).* www.irma-international.org/chapter/functional-polymeric-coatings/175713

Research Progress on Rheological Behavior of AA7075 Aluminum Alloy During Hot Deformation

Muhammed O.H Amuda, Taiwo F. Lawaland Esther T. Akinlabi (2017). *International Journal of Materials Forming and Machining Processes (pp. 53-96).* www.irma-international.org/article/research-progress-on-rheological-behavior-of-aa7075aluminum-alloy-during-hot-deformation/176061

Multi-Feature Optimization of WEDM for Ti-6AI-4V by Applying a Hybrid Approach of Utility Theory Integrated With the Principal Component Analysis

Sachin Ashok Sonawaneand M.L. Kulkarni (2018). *International Journal of Materials Forming and Machining Processes (pp. 32-51).*

www.irma-international.org/article/multi-feature-optimization-of-wedm-for-ti-6al-4v-by-applying-ahybrid-approach-of-utility-theory-integrated-with-the-principal-component-analysis/192158

Novel Compounds of Imidazole Derivatives as Effective Corrosion Inhibitors for Mild Steel in Hydrochloric Acid Solution: Electrochemical and Spectroscopic Characterization

Moussa Ouakki, M. Galai, Z. Aribou, M. Rbaa, B. Lakhrissiand M. Cherkaoui (2020). *New Challenges and Industrial Applications for Corrosion Prevention and Control (pp. 132-155).*

www.irma-international.org/chapter/novel-compounds-of-imidazole-derivatives-as-effectivecorrosion-inhibitors-for-mild-steel-in-hydrochloric-acid-solution/260772

An Ergonomic Analysis on Working Postures of Construction Site Workers: A Framework for Construction Site Workers

Suchismita Satapathy (2018). Handbook of Research on Ergonomics and Product Design (pp. 172-196).

www.irma-international.org/chapter/an-ergonomic-analysis-on-working-postures-of-constructionsite-workers/202656